The Short Run Impact of Scheduled Macroeconomic Announcements on the Australian Dollar during 1998

Terry Boulter*
School of Economics and Finance
Queensland University of Technology
GPO Box 2434 Brisbane Queensland 4001

Phone: (07) 3864 4311
Fax: (07) 3864 1500
E-mail t.boulter@qut.edu.au

and

Celeste Ping Fern Tan
School of Economics and Finance
Queensland University of Technology

ABSTRACT

This study examines the high frequency reaction of the Australian Dollar (AUD) to new information contained in scheduled macroeconomic news releases in Australia for 1998 using Money Market Services trader expectations data. By using exchange rate data sampled at 10-second intervals, major price adjustments are found to begin almost immediately following the initial release of information and are complete within one minute of the announcement. There is some evidence of over-reaction after the initial release but returns in the first minute do not seem to have any meaningful structure that would enable prediction of returns in the second minute. The AUD appears to trade efficiently and the market absorbs new information quickly.

INTRODUCTION

This study examines the short run effect of public news announcements, particularly macroeconomic news announcements, as they impact on the Australian dollar exchange rate for the year 1998. Specifically we examine the influence of scheduled macroeconomic news as it relates to the Gross Domestic Product, the Current Account Balance, the Consumer Price Index and the Unemployment rate. We use high frequency tick by tick data for the exchange rate and market survey data as a proxy for market expectations. We define news as the difference between the actual news announcement and the market expectation.

In section 2 of this paper we briefly review the literature relating to information arrival and market efficiency. In section 3 we provide a description of the data and methodology. In Section 4 we find that major price adjustment begins almost immediately after a scheduled announcement and that it is complete within a minute. There is some evidence of a persistent immediate over-reaction of returns in the initial minute but we are unable to detect any meaningful structure that would enable prediction of future returns in the second minute. We do not find evidence of information leakage. In Section 5 we summarise our conclusions.

BACKGROUND

With the abandonment of the Bretton Woods agreement on fixed exchange rates, the global foreign exchange (FX) market appears to have become markedly more volatile. Researchers such as Mussa (1986) have found that variability of real exchange rates is eight to eighty percent greater than it was during the fixed exchange era. Dornsbusch and Frankel (1987) note that, "exchange rates are more volatile than they were expected to be, than they should be, and than they need be". These findings are similar to those of Baxter and Stockman (1989), Artis and Taylor (1988) Eichengreen (1988), MacDonald and Zis (1989) and others.

Researchers have taken a number of different tacts in their attempts to gain a better understanding of FX volatility. Rose (1994) has focused on the connection between economic fundamentals and foreign exchange volatility, De Grauwe, Dewachter and Embrechts (1993) and Rao (1993), have used chaotic models, and Frankel and Froot (1987), have used expectations and survey data to forecast exchange rates. Results have been mixed and irresolute. One area of research that has been particularly fertile has been the examination of the relationship between volatility and information arrival. Frankel (1981), Goodhart and Smith (1985), Hakkio and Pearce (1985), Bollerslev and Melvin (1994), Hogan and Melvin (1994) Melvin and Tan (1996) have all modelled volatility in relation to information arrival with interesting results. There exist similar research that examines how exchange rates move immediately after economic announcements, however, most of this research does not use high frequency data. Cornell (1982), Engel and Frankel (1984), Hardouvelis (1984), Frankel and Hardouvelis (1985), and Roley (1987) examine the response of exchange rates to weekly money supply announcements in the US and find that unexpected components of the announcements led to an immediate appreciation of the domestic currency.[1]

Contemporary studies are now using higher frequency data to model volatility dynamics in relation to news announcements. Baillie and Bollerslev (1990), Harvey and Huang (1991; 1992), Goodhart et al (1993), Goodhart and Giugale (1993), Ederington and Lee (1993; 1995), Almeida, Goodhart and Payne (1996), and Tanner (1997) use high frequency intraday data in order to study how exchange rates react to macroeconomic announcements and have been able to provide deeper insights into exchange rate volatility dynamics. Harvey and Huang (1991; 1992), Goodhart and Giugale (1993), and Berry and Howe (1994) examine the impact of public information flow to the financial market in order to document information arrival patterns using high frequency time series data sets. All three studies find seasonal volatility patterns but more importantly, they find evidence of an increase in volatility when there are macroeconomic news announcements on a particular trading day.

Using intra-daily data from foreign currency futures Ederington and Lee (1995) study price adjustment to new information in interest rate and foreign exchange markets by focusing on the adjustment immediately following news releases using both 10-second interval returns and tick-by-tick data. They also explore overreaction possibilities and test for information leakage and correct for the volatility bias and spurious serial correlation caused by bid-ask spreads. Following Ederington and Lee

[1] MacDonald and Torrance (1988; 1990) also find similar results using weekly announcements and survey data for market expectations in the British pound.

(1995), this study examines the efficiency of the intra-day foreign exchange market as it relates to the Australian dollar for 1998. Like Ederington and Lee (1995), this study also looks at the price adjustment immediately following an announcement at 10-second intervals within a 15-minute window. This study however goes a step further by observing the relationship between the size of AUD volatility in 1998, and the size of the difference between actual announced figures and market expected figures.

DATA AND METHODOLOGY

Data Description

The exchange rate data covers the period from 01/01/98 (at GMT 02:01:20) to 31/12/98 (at GMT 23:59:52), and was received as an irregularly spaced, continuous time series set of USD/AUD quotations as quoted on Reuters' screens.[2]

The other portion of the data set consists of Australian macroeconomic announcements covering the same period, including a market expectation series for each type of announcement obtained from Money Markets Services International (MMS).[3] The list of macroeconomic announcements used in the "news" analysis is as follows: Gross Domestic Product, Current Account Balance, Consumer Price Index, and Unemployment, and there subsequent release dates and times are shown in Appendix A.

This study examines a total of 24 observations for 1998.[4] The announced figures correspond to their respective values of the month to the date of the announcement hence there is an approximate one-month lag to the announcement.[5] "News releases" for this purpose represented all public economic announcements by the ABS during this period. Although a comparatively few other public economic announcements will also have brought about changes in the exchange rate, this study chose to concentrate only on these events.[6] These four economic announcements are important economic announcements which provide information about the state of the economy, and which are closely watched by economic forecasters.

The survey medians of the responses of the latest available MMS survey are used to measure market expectations. Other studies have also utilised MMS survey data and have used the median predictions as proxies for market expectations of the announcements.[7] Karfakis and Kim (1995) have tested the unbiasedness of the medians as predictors of the announced figures. Their results show that the medians are unbiased, and thus can be used as proxies for market expectations of the

---

[2] Data was provided by Olsen & Associates.

[3] Our special thanks to Steven Kirchner of Money Markets Services International in Australia, who provided this data free of charge.

[4] The GDP, BOP current account and CPI figures are released quarterly while Unemployment figures are released monthly in the Australian Bureau of Statistics (ABS) publications.

[5] In some instances, there was a lag of nearly 2 months in the announcement date and month of the actual series.

[6] Previous authors such as Hakkio and Pearce (1985), Hardouvelis (1988), Hogan and Melvin (1994), Ederington and Lee (1993; 1995), and Tanner (1997), have also looked at other economic announcements in addition to these 4, such as, money supply, Producer Price Index and interest rates.

[7] For a survey of these studies, see Hardouvelis (1988), Singh (1993; 1995), Ederington and Lee (1993; 1995), Karfakis and Kim (1995), Almeida, Goodhart and Payne (1996).

announcements. This data allows for the separation of the series relevant to each type of announcement into an unexpected and expected component. News in this study is defined as the unexpected portion of an announcement, which is simply the difference between the market expectation and the actual announcement.

Appendix B reports the summary statistics of the AUD returns. The returns have a mean and median that are very close to zero, a standard deviation of 0.001504. Returns are positively skewed and significantly more peaked than a normal distribution. Given a significant Jarque-Bera value of 101413.4, the normality assumption of this study's returns data is rejected. Furthermore, the returns distribution with a kurtosis value of 19.61381 is greater than 3 therefore, the distribution is more representative of a leptokurtic (slim or long-tailed) distribution. The autoregressive conditional heteroskedasticity (ARCH) test indicates that consistent with most financial series data, there are ARCH effects within the returns data.

Methodology

Over the sample period, all macroeconomic announcements were released at 11.30am Canberra time. The time was adjusted backwards by 10 hours from Canberra time (and by 11 hours due to daylight saving for the appropriate periods) before the15 minute window periods for each announcement were identified. Each window starts 5 minutes before the news release and ends 10 minutes after the announcement. For comparison of return volatility between announcement and nonannouncement periods, a 15-minute nonannouncement volatility data set consisting of observations from days where none of the 24 announcements took place was constructed. The observation times in this set match those in the announcement sample. For example, if an announcement falls on a Wednesday, then for comparison purposes, only 11.25am to 11.40am nonannouncement Wednesdays are included in the nonannouncement data set.

The instantaneous variance for each observation is calculated by the square of the difference between the log difference in the AUD returns as in equation (1) and the average of these log differences in AUD returns.

$$\Delta S_t = In(S_t) - In(S_{t-1})$$

$$= In\left(\frac{S_t}{S_{t-1}}\right) \qquad (1)$$

Hence, the instantaneous variance for each observation is given by:

$$\left(\Delta S_t - \Sigma \Delta S_t\right)_t^2 \qquad (2)$$

We also wish to remove the systematic component, or systematic variance, of the instantaneous variance. In other words we are only interested in the variance that is associated with noise that is different from the average in the market. We create unsystematic variance by subtracting systematic variance from instantaneous variance. Systematic variance is calculated as the average of the instantaneous variances derived in equation (2) for the AUD returns data over the 15-minute window period as in equation (3).

$$\frac{\Sigma\left(\Delta S_t - \Sigma\Delta S_t\right)^2}{N} \quad (3)$$

After subtracting the systematic variance from each instantaneous variance as calculated in equation (2)) for the whole data set, we get the values of the nonsystematic variance (see equation (4)).

$$\left(\Delta S_t - \Sigma\Delta S_t\right)_t^2 - \left[\frac{\Sigma\left(\Delta S_t - \Sigma\Delta S_t\right)^2}{N}\right] \quad (4)$$

The nonsystematic variance data series, after being calculated and sliced from the entire data set for the relevant time period, are then subsequently plotted for every 10-second interval from 5 minutes before the release through 10 minutes after for each announcement.

The calculation of the average time between price changes as shown in Table 7 is the average time taken for price to change from one value to another within a specific time interval, for example 10 seconds, within a 15-minute window. The calculations of the average percentage of price changes exceeding one tick ($0.0001) in size as shown in Table 8 are the number of price changes that are greater than one tick in size over the total number of price changes, within a specified time interval in the 15-minute window, expressed as a percentage. Similarly, the total number of price reversals are calculated as the aggregate number of any changes in price direction within a specified time period. In summary, these calculations are undertaken using MATLAB© and sliced out to create windows of observations for the relevant 15-minute period around the announcement times.

RESULTS

Price Volatility

The nonsystematic variances of the AUD returns for every 10-second interval from 5 minutes before the release (-300 seconds) through 10 minutes after (+600 seconds) calculated across the 24 announcement days are shown in Figure 7 together with the corresponding return nonsystematic variances for the nonannouncement days.[8] A very distinctive feature can be seen in most of the volatility patterns. There is a sharp increase in the first 10-second interval (0, 10) following the news release (the times in the x-axis are interval ending times). This implies that the market responds within the first 10 seconds following the news release. Volatility peaks in the (0, 10) and (10, 20) period for the BOP current account and Unemployment announcements respectively while volatility peaks in the (80, 90) and (540, 550) period for the CPI and GDP announcements respectively. It appears that all four announcements have an impact on the exchange rate except that volatility peaks differ for each announcement. This suggests that the market is relatively efficient.

[8] The nonsystematic variance of 1) CPI: 4 announcement days with 44 nonannouncement days (Wednesdays), 2) GDP: 4 announcement days with 44 nonannouncement days (Wednesdays), 3) BOP current account: 4 announcement days with 100 nonannouncement days (49 Tuesdays & 51 Fridays), and 4) Unemployment: 12 announcement days with 40 nonannouncement days (Thursdays).

The nonsystematic variances decline following the (0, 10) and (10, 20) peaks for the BOP current account and Unemployment announcements but remain significantly higher than on nonannouncement days throughout the 10 minute period after the news release. In contrast, the nonsystematic variances for the GDP announcements continue to increase after the news release, only peaking slightly more than 8 minutes (550 seconds) after the news release. The major price adjustment for the CPI announcements occurs within the first two minutes and continues with a spike in the (350, 360) period before moving back to nonannouncement levels.

Volatility for all four announcements remains higher than on nonannouncement days where a few volatility spikes are observed throughout the 10-minute period after the news release. The implication for the BOP current account and Unemployment announcements is that the major price adjustment occurs within one minute after the news release but that prices continue to adjust for at least 10 minutes before moving back to the equilibrium level. The volatility for the Unemployment announcement drops to near equilibrium level two minutes following the announcement except for a small spike in the (270, 280) period compared to the other three announcements. For the BOP current account announcement, volatility continues to be particularly high after time 0. The increase in the nonsystematic variance is particularly strong following the announcements. In fact, the nonsystematic variance on all announcement days is 100 times greater than the nonsystematic variance for the nonannouncement days for several intervals within the first minute.

In summary, all four announcements appear to have an impact on the Australian dollar. Price adjustments start immediately after a news release and continue for at least 10 minutes. The increase in nonsystematic variance is strong following the news releases for all four announcements. Volatility is slightly and significantly higher than on nonannouncement days in most intervals before time 0 for all four announcements. This phenomena is similar to that observed by Ederington and Lee (1995). This higher volatility before the news release is contrary to the conventional opinion that traders withdraw from the market before major announcements due to higher uncertainty (Ederington and Lee, 1995: 121).

Individual Volatility Patterns

Figure 8 displays four of the nonsystematic variances of the AUD returns with the same window period as the aggregate volatility patterns for the four macroeconomic news announcements shown in Figure 7. Only one event is shown for each of the four macroeconomic news announcements.[9] Similar to the aggregate volatility patterns in Figure 7, a sharp increase in the first 10-second interval (0, 10) following the news release is observed in each of the events in Figure 8. This implies that the market responds within the first 10 seconds following the news release. Volatility peaks in the (10, 20) period for the Unemployment announcement (08/10/98), (80, 90) period for CPI (28/10/98) and GDP (02/09/98) announcements, and (580, 590) period for BOP current account announcement (03/03/98). Thus, there is evidence that the market is responding quickly to the arrival of new information. This indicates that the market is relatively efficient.

[9] The rest of the 20 news releases are available from the author on request.

The nonsystematic variances decline sharply following the (10, 20) peak for the Unemployment announcement and remain near to nonannouncement level except for two small spikes in the (360, 370) and (440, 450) period. Thus, prices tend to adjust immediately after the news release and volatility quickly moves back to near nonannouncement level. This may indicate that the market quickly absorbs the news within the first minute after the news release. Similarly, the nonsystematic variances decline sharply following the (80, 90) peak for the GDP announcement and within four minutes (240 seconds) after the news release, a new volatility equilibrium is formed which is slightly below the nonannouncement level. Volatility for the BOP current account announcement on the other hand, remains higher than on nonannouncement days after the news release indicating that prices continue to adjust for at least 10 minutes. Likewise, for the CPI announcement, prices continue to adjust after the news release and volatility also remains higher than on nonannouncement days after the news release.

To summarise, there is an increase in volatility following a news release with some volatility spikes being observed throughout the 10-minute period after the news release. In all four cases, the increase in nonsystematic variance is strong following the announcements. The nonsystematic variances on these four announcement days are more than 100 times greater then those on nonannouncement days. Volatility is also higher than on nonannouncement days in most intervals before time 0 for the CPI and GDP announcements while volatility for the Unemployment announcement is very close to that of nonannouncement days. For the BOP current account announcement, volatility is lower than on nonannouncement days before time 0, indicating that traders probably withdraw from the market just before the news release due to uncertainty. This is probably because the BOP figures, compared to the other three announcement figures, come from various sources and the complexity involved in calculating the BOP figures makes the initial calculation skeptical. Therefore, traders may find it difficult to assess future price movements. Furthermore, the announced BOP figures are usually inaccurate which require adjustments after the news release hence, BOP figures for previous quarters are usually different from their initial reported figures. Consequently, it may be the case that traders withdraw from the market just before BOP announcements due to uncertainty.

Price Changes

Table 7 displays the statistics on the average time between price changes, the percentage of price changes exceeding one tick in size, and the number of price reversals for the four macroeconomic announcements. The table is based on tick-by-tick data and the figures for 10-second intervals between –60 and +120, and 1-minute intervals outside this window (3 minutes before and 8 minutes after) are reported. The averages on nonannouncement days for the same (-300, 600) window are also shown at the bottom of the table for comparison.

The average time between price changes on announcement days immediately following the news release (0, 10) is four seconds. In fact, within the (-60, 120) period price changes average around three seconds for the BOP current account announcement. It remains roughly at this level before rising to 10 seconds by two minutes after the news release and averages around 12 seconds within the (120, 600) window. However, on nonannouncement days, the average time is six seconds.

Roughly the same price-changing pattern is observed for the CPI, GDP, and Unemployment announcements.

Overall, the average time between price changes for all four announcements is around four seconds immediately after the announcements (0, 10). The average time within the (-60, 120) window falls significantly compared to those outside this period implying that volatility starts to increase one minute before and two minutes after a news release. As shown in the second Panel in Table 7, the number of price changes exceeding one tick ranges between 20 to60 percent one minute before and two minutes after time 0 for the BOP current account, CPI and GDP announcemnts. The percentage of price changes exceeding one tick in size for these three announcements declines one minute before the news releases and is 0 most of the time within the (-60, 120) period.

The observed 0 percent of price changes exceeding one tick in size around the time of news releases can be attributed to either there being no price changes at all during this period or there are many price changes but most of which are less than one tick in size. The latter's explanation is more likely the case because the volatility patterns shown in Figures 7 and 8 indicate that price adjustments are taking place around the time of the news releases. Hence, for these three announcements, the number of price changes less than one tick in size increases when time approaches 0 and this continues for around two minutes after the news releases before moving back to near nonannouncement levels, where over 60 percent of price changes are less than one tick in size.

Roughly, the same pattern is observed for the Unemployment announcement, where the percentage of price changes exceeding one tick in size starts to decline one minute before the news release and remains lower than on nonannouncement days for two minutes after time 0 before moving back to the nonannouncement level. However, unlike the other three announcements, the percentage of price changes exceeding one tick in size for the Unemployment announcement is slightly higher within the (-60, 120) period although it is still significantly lower than on nonannouncement days.

In general, the percentage of price changes exceeding one tick in size for all four announcements starts to decline one minute before the news releases and generally remains lower than on nonannouncement days for around two minutes after the news releases before moving back to nonannouncement levels. This implies that, as evidenced in Figures 7 and 8, there are many price changes most of which are less than one tick in size, during the (-60, 120) period and prices gradually move back to that of nonannouncement days after two minutes. This would seem to indicate that the increase in volatility following news releases is not due to large price changes (more than one tick in size). Thus, prices do not appear to jump from one equilibrium level to another instantaneously, in fact, the absence of large price changes within the (-60, 120) period is evident in all four announcements, particularly the BOP current account announcements.

Efficiency and Leakage

The first order serial correlation coefficients between successive 1-minute and 3-minute returns for the 15-minute window are reported in Table 9. Results for all 24 announcements are shown in Panel A. For comparison, the correlation coefficients

between successive returns for the same time period and intervals for the preceding and corresponding nonannouncement days are also reported in Panels B and C. It is clear from the results in Table 9 that there are few significant serial correlations within the 15-minute window period for the BOP current account, CPI and GDP announcements, but slightly more for the Unemployment announcement. Furthermore, most announcement period serial correlation coefficients for these four announcements are negative and where these negative coefficients are significant, it indicates that the prices tend to move in opposite directions over successive intervals. This is counter intuitive and thus although significant, should be viewed skeptically as a statistical aberration.

The coefficients of the BOP current account, CPI and GDP announcements prior to the news releases are insignificant. Evidence of serial correlation appears to arise after time 0 in most cases for all four announcements. Although some are still significant around 10 minutes after the news releases, most serial correlations are evident around one and two minutes after time 0. Since most correlations are negative, this raises the possibility that the market may tend to overreact to news initially and then make corrections in later periods such as 10 minutes after the news releases. This interpretation should be viewed sceptically for a number of reasons. Since there are only a few correlation coefficients in Table 9 that are significant, their predictive power is weak. A coefficient of –0.716 (for the GDP news release on 03/06/98) implies that only 4.3 percent of the variation in returns in the first minute following the news release can be predicted by the returns in the previous one minute before time 0.

Secondly, returns in successive minutes on nonannouncement days tend to be negatively correlated, which are consistent with a market where prices tend to fluctuate around an equilibrium level with the arrival of buy and sell orders. The evidence of serial correlation on nonannouncement days can also be due to the arrival of other pieces of information other than the four macroeconomic announcements examined in this study. However, the significant correlations observed on nonannouncement days is more randomly spread out within the 15-minute window compared to that on announcement days which cluster together after time 0.

In summary, most price adjustments for all four announcements seem to take place immediately after the news releases and by the end of 10 minutes prices are fluctuating around an equilibrium price level similar to that on nonannouncement days. In most cases, returns in the first minute do not appear to have any predictive power of returns in the second minute. This is also evidenced by the volatility patterns in Figures 7 and 8. This indicates that the price level soon after a news release is a relatively unbiased predictor of the equilibrium price. This is further supported in the next section, which will look at the number of price reversals as an alternative method to examine price relationships following a news release.

Price Reversals

The number of price reversals is presented in the third Panel Table 7. The number of price reversals provides an alternative way of examining whether any relationship exists between price changes following a news release. If the number of price reversals after a news release is lower than that on nonannouncement days, this may imply that the market is taking a longer time to absorb new information. Thus, if the

market is efficient in terms of absorbing information, the number of price reversals should approach that of nonannouncement levels soon after the news releases.

Price changes are assigned to the intervals according to their ending time. For instance, if a price at t = 4 is 0.6748, a price at t = 7 is 0.6725, and a price at t = 11 is 0.6750, the price reversal between t = 7 and t = 11 would be assigned to the (10, 20) interval. As the number of price reversals reported are in absolute numbers, the figures for the nonannouncement days are adjusted proportionally to the number of announcement days for comparison purposes. For instance, the nonannouncement price reversals for CPI announcements are adjusted to four days since the news releases occurred in four separate days throughout the year. Likewise, the nonannouncement price reversals for Unemployment announcements are adjusted to 12 days since the news releases occurred in 12 separate days throughout the year. Hence, after adjustment, the number of price reversals on nonannouncement days for BOP current account announcement is 45, 55 for both CPI and GDP announcements and 160 for Unemployment announcement.

The number of price reversals tends to decrease nearing the time of a news release for the BOP current account, CPI and GDP announcements and within the (-60, 120) period, the number of price reversals is sometimes 0. This implies that either price tend to remain constant (that is, no price changes) within this period or price changes are trending, that is, moving in the same direction around the time of a news release. The latter explanation is most likely the case as evidenced by Figures 7 and 8 where there is an increase in volatility around time 0 implying that price adjustments are taking place. The Unemployment announcement also follows a similar pattern to the other three announcements except that the number of price reversals are slightly larger (over 10 and 20) compared to the rest, and exhibiting fewer 0 price reversals within the (-60, 120) period.

The number of price reversals starts to increase two minutes after the news releases for all four announcements and there are some indications that the price level following a news release is a relatively unbiased predictor of the equilibrium price. The number of price reversals for the CPI and GDP announcements approaches that of nonannouncement levels after 10 minutes. Following the news releases, the number of price reversals for the BOP current account and Unemployment announcements moves above that of nonannouncement levels. This may imply that the market is quite efficient in absorbing information regarding these four announcements since the number of price reversals starts to approach the nonannouncement levels soon after the news releases. However, it is only the speed of price adjustments that differ among these announcements. Price adjustments take a slightly longer time (more than 10 minutes) to reach nonannouncement levels for the CPI and GDP announcements while the market takes less than 10 minutes to fully absorb new information regarding BOP current account and Unemployment.

Leakage

Table 7, Figure 7 and most cases in Figure 8 show evidence of higher than normal price activity before a news release. This could indicate information leakage where market participants with prior knowledge of the upcoming announcement get a jump on trading before the announcement, or that traders are making final revisions of their expectations based on other information arriving immediately prior to the

announcement. Table 9, shows that there is evidence of negative serial correlation for Unemployment announcements, but not for the other three announcements before time 0. However, volatility patterns for all cases as evidenced in Figures 7 and 8 are still increasing after time 0 before declining one or two intervals later. This seems to indicate the presence of noise trading which is probably generated by the upcoming news releases. That is, the increase in price volatility is due to the market's anticipation of the actual announced figures in relation to the market's expectations. For instance, if the market expects an increase in GDP growth (bullish information) in the upcoming GDP announcement, market participants may start to trade based on this expectation in the hope of capturing excess returns.

Market Reaction to New Information

Table 11 reports statistics relating to the degree of volatility, and the size (ie difference between actual and expected) and type of "news" for all the 24 news releases. The size of "news" is the percentage difference between the actual announced figure and the market expected figure. The volatility size is the percentage difference between the average price volatility (that is, the nonsystematic variances) of a particular news release and the average price volatility of the corresponding nonannouncement days for the year of 1998 within the same (-300, 600) window. For instance, the volatility size of a GDP news release on 04/03/98 (Wednesday) is calculated from the percentage difference between the average volatility of this news release within the (-300, 600) window and the average volatility of all nonannouncement Wednesdays in 1998 for the same window period (see Appendix F for a breakdown of the size of volatility and unexpected information for all 24 announcements).

Ignoring the negative signs and focusing only on the absolute figures, a comparison can be made between the size of the unexpected component of the information content and the corresponding volatility size. For the BOP current account announcements, the unexpected component embodies 2.4% (on 02/06/98) and 0.2% (on 01/12/98) of the announcement which resulted in a 20.8% and 14.4% increase in volatility respectively. However, when the unexpected component constitutes 10.5% of the public information, the volatility size is only 6.2%. This appears to be counter intuitive in that one would expect that where the announcement contains more "news", there would be some proportional increase in volatility. However, this is not the case, in fact, the results show an inconsistency in volatility size and unexpected information.

A possible explanation for this in relation to the BOP current account is that the proxy for market expectations - the Money Market Service survey data, is not a good representative of the true market expectations. However, this does not mean that the survey results are not rational. The survey participants form their expectations about future macroeconomic variables rationally but the market is comprised of many more market participants whose expectations can also be rationally formed yet differ from those surveyed. Alternatively, it could be the case that the market does not view the economic indicator (in this case, BOP current account) as having a significant relationship to the Australian dollar. If this is true, then it may be possible to prioritise announcements according to their relative importance to market participants. However, this should be viewed skeptically because the observed phenomena may be

the case for a specific news release at a particular point in time only and not for a particular economic indicator as a whole.

The volatility size differs significantly for the GDP announcements where the unexpected component is the same on 04/03/98 and 02/12/98 at 0.2%. Unemployment announcements also exhibit a similar pattern to the GDP announcements where the same amount of unexpected information (0.1%) results in different volatility sizes. However, as discussed earlier, this apparent inconsistency in volatility size and the amount of unexpected "news" could be due to the relative importance of the news release, as assigned by market participants at a particular moment in time. In the GDP case, for instance, the large volatility size of 619.4% on 04/03/98 as opposed to that of 7.4% on 02/12/98 when the amount of "news" is the same at 0.2% may imply that the market feels that the news release on 04/03/98 is more important than the one on 02/12/98. This could be due to the market's interpretation of the news. For example the news release on 04/03/98 provides an account of the 4th quarter GDP growth in 1997. This information, together with the previous quarterly GDP news releases in 1997, will provide market participants an overview of the entire economic condition in 1997. The market may then use this overview to form their expectations about future exchange rate movements and the anticipated economic performance for 1998. Nevertheless, as mentioned earlier, this observed phenomena does not imply that, ceteris paribus, the market regards GDP announcements in general as very important. The results so far only indicate that market participants may regard a specific news release at a particular point in time as important. There is insufficient evidence to indicate whether a particular economic indicator is more important in affecting exchange rates compared to others. The relative importance of specific economic indicators will require a more detailed examination of all economic indicators which is beyond the scope of this study.

In contrast to the other three macroeconomic announcements, the market reaction to new information in relation to the CPI is in line with what one would anticipate. With more unexpected information contained in a public news release, a greater degree of volatility size is observed.

For the Unemployment figures a large volatility size is observed (279.5%) on 08/10/98 where the actual announced Unemployment figure is the same as the expected survey figure. This phenomenon is also observed on 12/03/98 as well as on 03/03/98 for the BOP current account announcements and on 29/04/98 for the CPI announcements.

CONCLUSION

This study has examined the impact of macroeconomic news announcements on the AUD using an event study approach. Price adjustments to new information begins almost immediately following a news release – generally within the first minute. Volatility continues to remain high for most announcements 10 minutes after time 0. This indicates that price adjustments are still taking place either because traders are slow to digest the implications of the information or because additional information is still flowing into the market. Price adjusts in a series of small rapid price changes indicating that individual market expectations are being played out before a clear price level establishes itself. Prices do not jump instantaneously from a previous equilibrium to a new one.

Major price adjustments to the initial release for most announcements are basically complete within one minute, if not, certainly within two minutes of the release. There also appears to be weak evidence of overreaction after the initial release and returns in the first minute do not seem to have any meaningful ability to predict returns in the second minute. There appears to be no information leakage prior to a news release, in fact, the higher than normal volatility is probably generated by the market's anticipation of the upcoming news release. Since volatility remains higher than normal in most intervals after the news release, it appears that those who disagree with the expectation data of the release's implications are readjusting their positions. Alternatively, further implicaitons resulting from the news release results in the continuation of price adjustment. However, these later price adjustments are independent of initial price changes in the first two minutes.

There are cases where the observed volatility size is greater with less news, and less with more news. There are also cases of an increase in volatility with the same "news". How to interpret this is difficult, but probably indicates that "new" is time and context specific. Our results only suggest that market participants regard specific news at a particular point in time as important but there is not enough evidence to indicate whether a particular economic indicator is more important than others.

APPENDIX A
Macroeconomic Announcements Data

Identifier	Announcement Type	Reported As	Time	Week	Obs.
GDP	Gross Domestic Product	% change	11.30EST	1	4
CAD	Current Account Deficit	$ billions	11.30EST	1/4	4
CPI	Consumer Price Index	% change	11.30EST	4	4
U	Unemployment	% level	11.30EST	1/2	12

"Week" refers to the usual trading week of each month when the given announcement is usually released. eg. GDP figures are generally published in the first week of the trading month.

APPENDIX B
Summary Statistics of AUD Returns

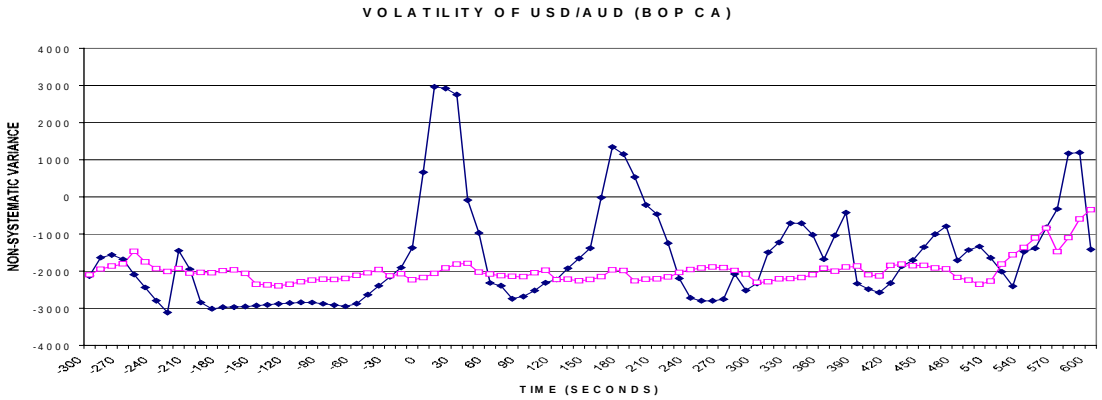
Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
-7.52×10^{-6}	0.000000	0.001504	0.681576	19.61381	101413.4	0.000000

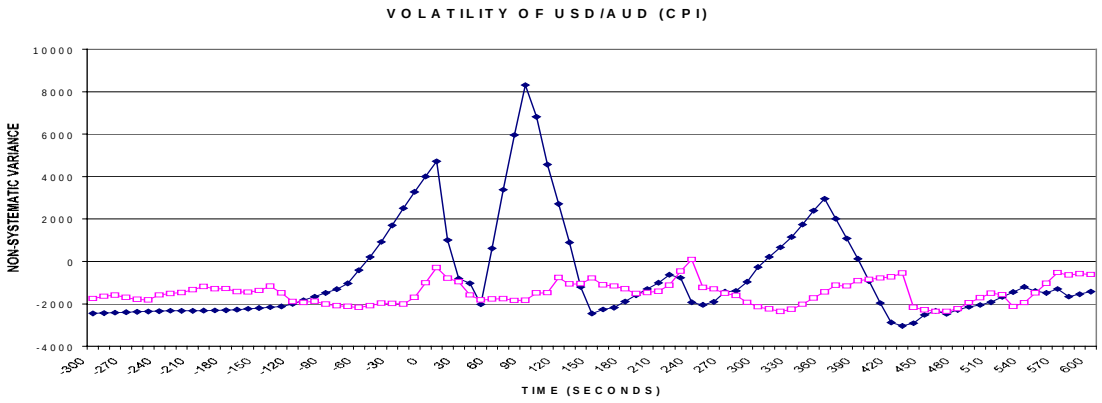
ARCH Test F-statistic	Probability
92.88057	0.000000

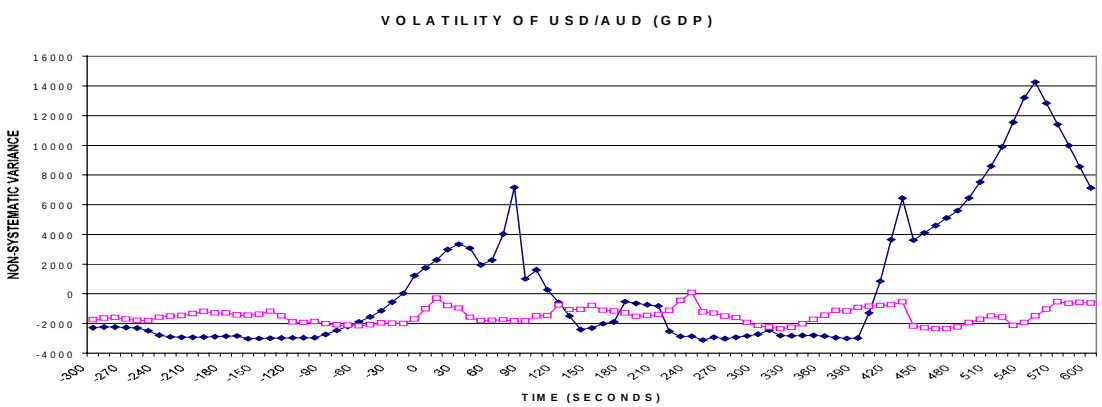
APPENDIX C

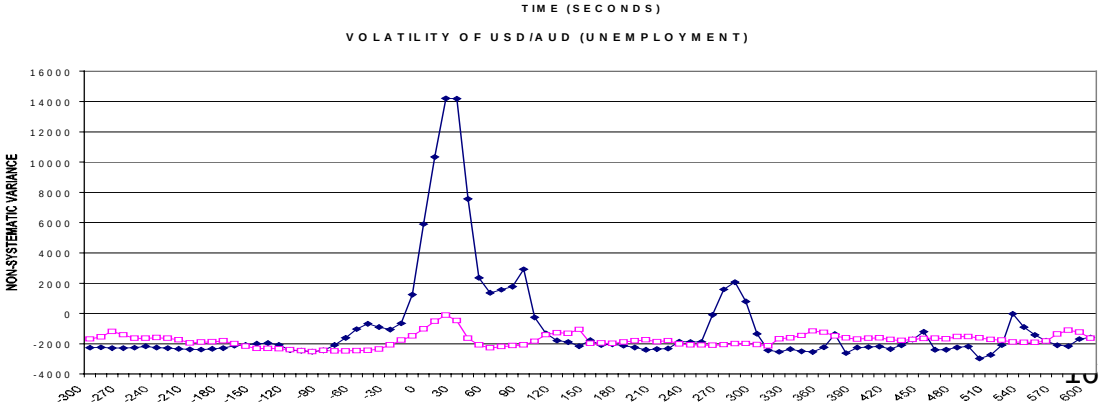
The Impact of Macroeconomic News Announcements on Volatility (Aggregate)

Nonsystematic variances of log returns for 10-second intervals are reported for macroeconomic announcement days (shaded diamonds) and nonannouncement days (open boxes). Returns are based on tick-by-tick prices, measured as the mean of the bid and ask quotes, from 01/01/98 to 31/12/98. The times on the x-axis are interval ending times in seconds relative to the announcement at time 0. Identical time periods on corresponding nonannouncement days are replicated in the nonannouncement sample. The reported nonsystematic variances are 10^{10} times the calculated values.





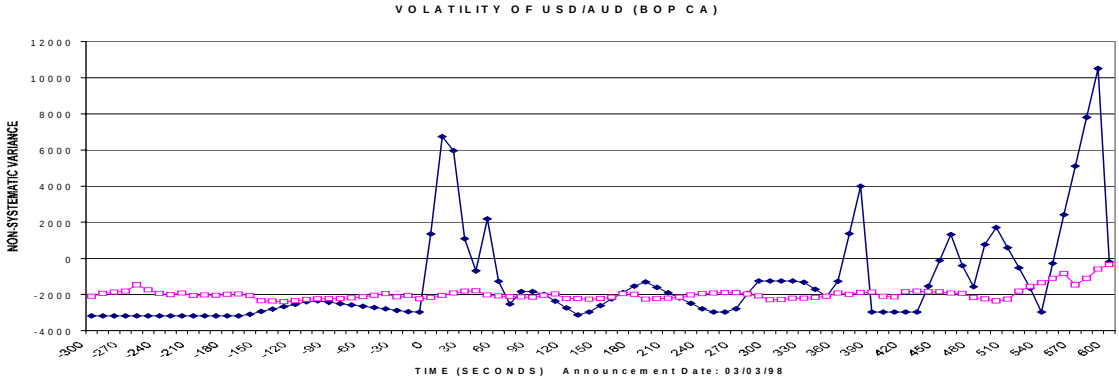




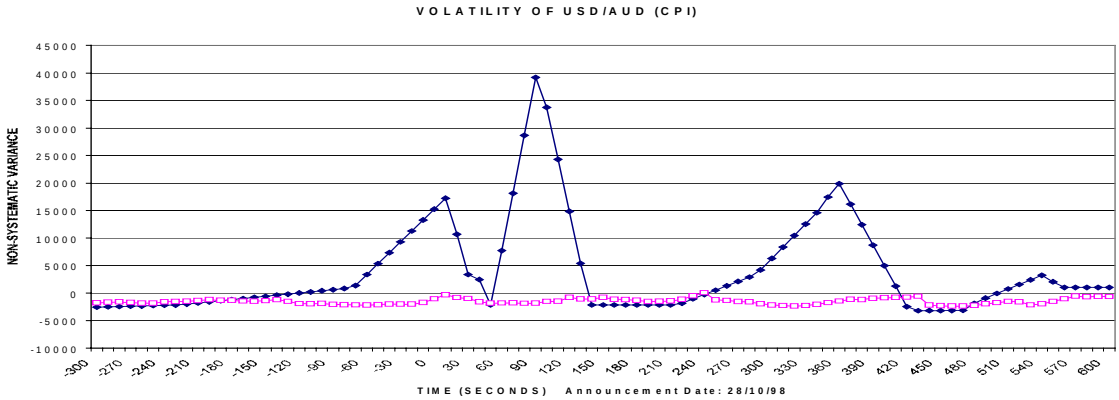
APPENDIX D

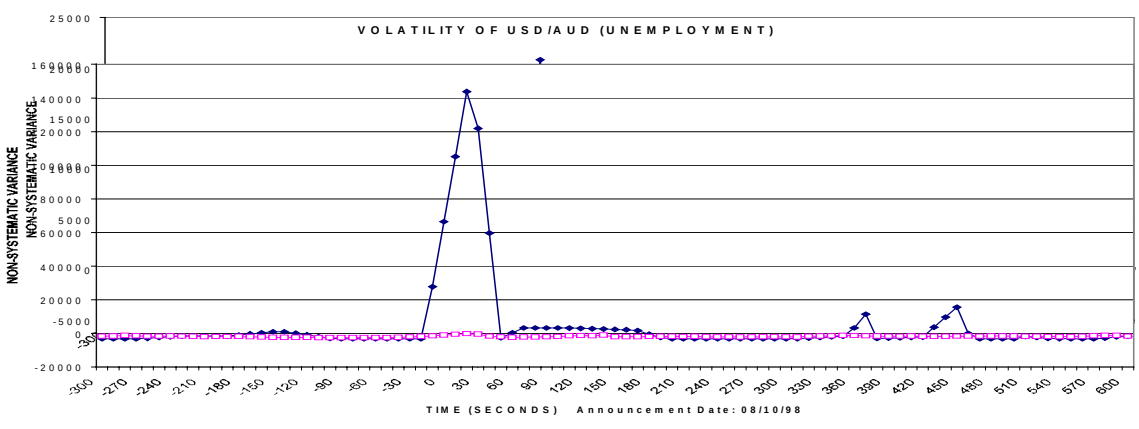
The Impact of Macroeconomic News Announcements on Volatility (Individual)

Nonsystematic variances of log returns for 10-second intervals are reported for specific macroeconomic announcement days (shaded diamonds) and their corresponding nonannouncement days (open boxes). Returns are based on tick-by-tick



prices, measured as the mean of the bid and ask quotes, from 01/01/98 to 31/12/98. The times on the x-axis are interval ending times in seconds relative to the announcement at time 0. Identical time periods on corresponding nonannouncement days are replicated in the nonannouncement sample. The reported nonsystematic variances are 10^{10} times the calculated values.





APPENDIX E

The Frequency, Size, and Direction of Price Changes following Macroeconomic Announcements

	Frequency				Size				Direction			
Time Interval (Seconds)	BOP Current Account	CPI	GDP	Unemployment	BOP Current Account	CPI	GDP	Unemployment	BOP Current Account	CPI	GDP	Unemployment
	Average Time between Price Changes (Seconds)	Average Time between Price Changes (Seconds)	Average Time between Price Changes (Seconds)	Average Time between Price Changes (Seconds)	Average Percent of Price Changes Exceeding One Tick	Average Percent of Price Changes Exceeding One Tick	Average Percent of Price Changes Exceeding One Tick	Average Percent of Price Changes Exceeding One Tick	Total number of Price Reversals	Total number of Price Reversals	Total number of Price Reversals	Total number of Price Reversals
Announcement Days												
(-300,-240)	10	12	12	12	43.8	0	75	37.5	4	0	2	6
(-240,-180)	12	14	14	18	25	31.3	20.8	31.3	3	1	4	5
(-180,-120)	10	12	12	12	37.5	41.7	25	20.8	2	1	3	12
(-120,-60)	14	16	16	10	0	25	12.5	29.2	2	2	2	8
(-60,-50)	4	0	0	2	0	0	25	0	0	0	0	2
(-50,-40)	3	0	0	4	50	25	50	8.3	0	1	0	2
(-40,-30)	2	2	2	2	0	25	0	25	0	0	0	0
(-30,-20)	3	4	4	0	0	62.5	0	0	0	1	0	2
(-20,-10)	2	4	4	2	0	25	12.5	0	1	1	1	2
(-10,0)	0	4	4	4	0	12.5	0	16.7	1	0	0	1
(0,10)	4	6	6	0	0	25	0	16.7	0	0	0	0
(10,20)	4	5	5	0	0	0	0	0	3	2	1	0
(20,30)	2	3	3	8	0	0	0	12.5	0	0	1	5
(30,40)	2	2	2	2	25	0	0	16.7	2	0	0	2
(40,50)	4	3	3	2	0	0	0	8.3	3	1	0	3
(50,60)	4	4	4	5	0	0	0	25	4	1	1	10
(60,70)	2	2	2	2	25	0	0	12.5	0	1	1	6
(70,80)	2	4	4	0	0	50	25	0	1	1	0	3
(80,90)	6	4	4	8	0	25	25	16.7	0	1	2	3

(90, 100)	2	8	8	6	0	25	50	16.7	2	1	2	7
(100, 110)	5	4	4	2	0	0	0	4.2	2	0	4	5
(110, 120)	2	4	4	4	0	25	0	16.7	1	1	0	3
(120, 180)	10	12	12	6	37.5	37.5	65	48.6	5	3	4	20
(180, 240)	14	12	12	12	70	62.5	6.3	43.5	7	1	2	23
(240, 300)	10	8	8	16	18.8	37.5	12.5	30	5	3	4	17
(300, 360)	10	16	16	8	62.5	50	0	33	4	6	6	15
(360, 420)	12	11	11	13	20.8	6.3	12.5	59	5	2	3	22
(420, 480)	10	8	8	9	79.2	31.3	25	47.5	7	5	2	15
(480, 540)	12	12	12	7	43.8	50	50	46.2	3	1	1	14
(540, 600)	16	14	14	8	57	45.8	25	41.7	7	4	4	9
(-300, 600)	6	3	6	6	63.3	55.8	47.1	45.9	74	41	50	222
Nonannouncement Days												
(-300, 600)	6	7	7	6	42.1	47.2	47.2	44.8	45	55	55	160

The average time (in seconds) between price changes, the percentage of price changes exceeding one tick in size, and the number of price reversals for announcements are reported as well as those for nonannouncement days for the same (-300,600) window. The table is based on tick-by-tick data from 01/01/98 to 31/12/98 inclusive.

APPENDIX F

Market Efficiency and Speed of Adjustment

BOP Current Account First Order Serial Correlation Coefficients

Panel A: Announcement Days (Tuesday and Friday)

Time Interval (seconds)	03/03/98	02/06/98	28/08/98	01/12/98
(-300,-120)	-0.382	-0.448	-0.417	-0.321
(-120,-60)	NA	NA	NA	NA
(-60,0)	-0.125	NA	-0.103	NA
(0,60)	-0.556*	0.093	-0.465	-0.08
(60, 120)	0.028	-0.456	-0.321	-0.025
(120, 180)	-0.237	-0.656*	NA	-0.295
(180, 240)	NA	-0.33	-0.326	-0.26
(240, 420)	-0.476*	0.221	-0.305	0
(420, 600)	-0.137	-0.109	-0.544**	-0.431

Panel B: Nonannouncement Days (preceding Tuesday and Friday)

Time	24/02/98	26/05/98	21/08/98	24/11/98

CPI First Order Serial Correlation Coefficients

Panel A: Announcement Days (Wednesday)

Time Interval (seconds)	28/01/98	29/04/98	23/07/98	28/10/98
(-300,-120)	NA	-0.283	-0.26	NA
(-120,-60)	-0.295	NA	NA	NA
(-60,0)	-0.573	NA	0.25	NA
(0,60)	NA	-0.143	0.104	-0.434
(60, 120)	-0.272	-0.767**	0.164	-0.655*
(120, 180)	-0.102	NA	-0.244	NA
(180, 240)	NA	NA	-0.436	NA
(240, 420)	-0.347	-0.213	-0.447	-0.187
(420, 600)	-0.325	-0.37	-0.275	0.095

Panel B: Nonannouncement Days (preceding Wednesdays)

Time	21/01/98	22/04/98	15/07/98	21/10/98

GDP First Order Serial Correlation Coefficients

Panel A: Announcement Days (Wednesday)

Time Interval (seconds)	04/03/98	03/06/98	02/09/98	02/12/98
(-300,-120)	0.064	-0.542	-0.111	-0.5
(-120,-60)	NA	NA	-0.327	NA
(-60,0)	0.196	NA	NA	NA
(0,60)	NA	-0.716**	NA	-0.031
(60, 120)	0.173	NA	-0.656**	-0.245
(120, 180)	-0.7**	-0.213	-0.354	NA
(180, 240)	-0.411	-0.071	NA	0.06
(240, 420)	0.053	-0.385	-0.266	0.012
(420, 600)	-0.525	-0.247	-0.375	-0.322

Panel B: Nonannouncement Days (preceding Wednesday)

Time	25/02/98	27/05/98	26/08/98	25/11/98

Interval (seconds)	8	8	8	8
(-300,-120)	-0.415	-0.46	-0.383	-0.289
(-120,-60)	NA	NA	-0.485	-0.272
(-60,0)	-0.787**	NA	NA	-0.518
(0,60)	NA	0.25	NA	NA
(60, 120)	NA	NA	NA	NA
(120, 180)	NA	NA	NA	NA
(180, 240)	0.04	0.25	NA	NA
(240, 420)	-0.146	-0.202	-0.3	-0.5
(420, 600)	-0.024	-0.319	-0.367	-0.295

Interval (seconds)	8	8	8	8
(-300,-120)	-0.198	NA	-0.25	-0.5
(-120,-60)	0.361	NA	NA	NA
(-60,0)	-0.154	-0.85**	-0.767**	NA
(0,60)	NA	NA	NA	-0.75**
(60, 120)	-0.609*	NA	-0.418	-0.217
(120, 180)	NA	NA	NA	-0.61*
(180, 240)	NA	0.128	NA	NA
(240, 420)	-0.049	-0.432	-0.575*	0
(420, 600)	-0.213	-0.492	-0.469	NA

Interval (seconds)	8	8	8	8
(-300,-120)	-0.336	-0.539*	0.159	0.033
(-120,-60)	NA	-0.214	NA	NA
(-60,0)	NA	-0.596*	NA	NA
(0,60)	NA	NA	-0.11	-0.002
(60, 120)	NA	NA	-0.2	-0.472
(120, 180)	NA	NA	NA	-0.561*
(180, 240)	NA	-0.496	NA	-0.34
(240, 420)	0.05	0.167	-0.005	-0.187
(420, 600)	-0.384	-0.521*	-0.214	-0.053

Panel C: Nonannouncement Days (following Tuesday and Friday)

Time Interval (seconds)	10/03/98	09/06/98	04/09/98	08/12/98
(-300,-120)	-0.209	-0.224	-0.165	-0.472
(-120,-60)	NA	-0.395	-0.693**	NA

Panel C: Nonannouncement Days (following Wednesdays)

Time Interval (seconds)	04/02/98	06/05/98	29/07/98	04/11/98
(-300,-120)	-0.493	-0.75**	-0.319	-0.494*
(-120,-60)	NA	-0.602*	NA	0.095

Panel C: Nonannouncement Days (following Wednesday)

Time Interval (seconds)	11/03/98	10/06/98	09/09/98	09/12/98
(-300,-120)	-0.475	0.326	-0.725**	0.021
(-120,-60)	NA	-0.372	NA	-0.285

(-60,0)	NA	NA	NA	NA	**(-60,0)**	0.108	NA	NA	-0.36	**(-60,0)**	-0.181	NA	NA	-0.416
(0,60)	NA	NA	-0.115	NA	**(0,60)**	-0.296	-0.703**	-0.573*	NA	**(0,60)**	-0.337	-0.234	NA	NA
(60, 120)	-0.407	NA	NA	NA	**(60, 120)**	-0.466*	NA	-0.509	NA	**(60, 120)**	0.048	NA	-0.205	-0.277
(120, 180)	NA	-0.018	0.155	NA	**(120, 180)**	-0.599**	NA	-0.553*	NA	**(120, 180)**	-0.778**	0.219	-0.605*	-0.262
(180, 240)	-0.265	NA	0.028	-0.426	**(180, 240)**	-0.636*	-0.808**	NA	-0.083	**(180, 240)**	-0.41	-0.379	NA	NA
(240, 420)	-0.093	0.27	-0.244	0.533**	**(240, 420)**	-0.351	-0.693**	-0.674**	-0.233	**(240, 420)**	NA	-0.278	-0.648**	-0.481*
(420, 600)	-0.141	-0.333	-0.196	-0.467*	**(420, 600)**	0.034	-0.362	-0.208	NA	**(420, 600)**	0.025	-0.069	-0.388	-0.262

First order serial correlation coefficients between log returns in 1-minute or 3-minute intervals and the preceding interval are reported. The same 1-and 3-minute interval coefficients for the (-300, 600) window for the preceding and following corresponding days are also reported for nonannouncement days. *and **denote significant at the 0.10 and 0.05 levels, respectively, in a two-tailed test. NA denotes either no price changes within that particular time interval or lack of observations to conduct a serial correlation test. The data set extends from 01/01/98 to 31/12/98 inclusive.

APPENDIX F - Continued
Market Efficiency and Speed of Adjustment

Unemployment First Order Serial Correlation Coefficients

Panel A: Announcement Days (Thursday)

Time Interval (seconds)	15/01/98	12/02/98	12/03/98	09/04/98	07/05/98	11/06/98	09/07/98	06/08/98	10/09/98	08/10/98	12/11/98	10/12/98
(-300,-120)	-0.005	-0.496*	-0.8**	-0.371	-0.702**	-0.426	-0.5	0	-0.539	-0.725**	-0.811**	-0.245
(-120,-60)	NA	NA	NA	NA	-0.801**	NA	NA	-0.573	NA	NA	0.195	0.028
(-60,0)	-0.381	-0.214	NA	-0.069	NA	0.687**	-0.417	NA	NA	NA	NA	NA
(0,60)	NA	-0.358	-0.806**	-0.062	-0.131	-0.177	-0.667**	-0.632**	0.117	-0.284	NA	NA
(60, 120)	-0.008	-0.767**	NA	-0.632**	-0.315	-0.307	-0.407	-0.418	-0.607*	-0.126	-0.341	-0.356
(120, 180)	-0.039	-0.515*	-0.005	-0.781**	-0.217	-0.042	-0.75**	-0.646*	-0.06	NA	-0.292	NA
(180, 240)	-0.226	-0.106	-0.119	-0.742**	-0.588**	NA	-0.072	0.15	NA	-0.359	0.163	-0.383
(240, 420)	-0.086	-0.794*	-0.537*	-0.421	-0.146	-0.614**	-0.159	-0.112	-0.665**	-0.028	-0.482	-0.561**
(420, 600)	0.143	0.025	-0.218	-0.588**	0.094	0.005	-0.397	-0.328	-0.589**	0.054	-0.389*	0.04

Panel B: Nonannouncement Days (preceding Thursday)

Time Interval (seconds)	08/01/98	05/02/98	05/03/98	02/04/98	30/04/98	04/06/98	02/07/98	30/07/98	03/09/98	01/10/98	05/11/98	03/12/98
(-300,-120)	-0.621*	-0.092	-0.449	-0.369	-0.605*	-0.562**	-0.632**	-0.776**	-0.605*	0.035	-0.313	-0.437
(-120,-60)	NA	NA	-0.643*	NA	NA	NA	NA	0.11	-0.7**	0.15	NA	-0.3
(-60,0)	NA	-0.227	NA	NA	NA	NA	NA	-0.662**	-0.284	NA	NA	NA
(0,60)	-0.52	NA	NA	NA	-0.115	NA	0.25	0	-0.799**	NA	0.123	NA
(60, 120)	0.254	NA	-0.417	0.274	NA	NA	NA	-0.423	-0.385	-0.284	NA	-0.5
(120, 180)	-0.404*	NA	-0.473	-0.454	-0.788**	0.204	-0.417	NA	NA	NA	-0.5	NA
(180, 240)	0.102	NA	NA	NA	NA	NA	NA	NA	-0.472	NA	0.039	NA
(240, 420)	-0.214	0	-0.48**	-0.573*	-0.472*	-0.336	-0.483	-0.584*	-0.363	0.034	-0.325	0.173

(420, 600)	-0.413	-0.094	-0.241	-0.318	-0.255	-0.333	NA	NA	-0.371	-0.071	NA	-0.5

Panel C: Nonannouncement Days (following Thursday)

Time Interval (seconds)	**22/01/98**	**19/02/98**	**19/03/98**	**16/04/98**	**14/05/98**	**18/06/98**	**16/07/98**	**13/08/98**	**17/09/98**	**15/10/98**	**19/11/98**	**17/12/98**
(-300,-120)	-0.347	-0.283	-0.262	0.1	-0.125	-0.437	-0.637**	-0.49	-0.707**	-0.608*	0.031	0.03
(-120,-60)	NA	NA	-0.486	-0.002	NA	-0.305	-0.382	NA	NA	-0.071	NA	0.142
(-60,0)	NA	-0.534	-0.449	0.026	NA	-0.789**	NA	-0.211	-0.268	NA	-0.5	NA
(0,60)	NA	-0.167	NA	NA	NA	-0.445	0	NA	NA	-0.123	-0.528	NA
(60, 120)	NA	NA	NA	-0.633*	-0.249	NA	NA	NA	NA	NA	-0.622*	-0.5
(120, 180)	NA	-0.5	-0.417	-0.647*	0.222	-0.382	NA	-0.518*	NA	NA	0.026	NA
(180, 240)	NA	NA	NA	NA	NA	-0.8**	NA	-0.538	NA	NA	0	-0.074
(240, 420)	0.11	-0.149	-0.001	-0.418	-0.415	-0.235	-0.05	-0.434	-0.324	-0.131	-0.41	-0.145
(420, 600)	0.039	-0.346	0	-0.472	-0.527	-0.482	-0.5	-0.52	-0.641**	0.076	-0.403	-0.039

First order serial correlation coefficients between log returns in 1-minute or 3-minute intervals and the preceding interval are reported. The same 1-and 3-minute interval coefficients for the (-300, 600) window for the preceding and following corresponding days are also reported for nonannouncement days. * and ** denote significance at the 0.10 and 0.05 levels, respectively, in a two-tailed test. NA denotes either no price changes within that particular time interval or lack of observations to conduct a serial correlation test. The data set extends from 01/01/98 to 31/12/98 inclusive.

APPENDIX G

Unexpected Information Relative to Volatility Size

	Unexpected change (%)	Difference in volatility (%)		Unexpected change (%)	Difference in volatility (%)
BOP current account			**Unemployment**		
03/03/98	0.0	-0.2	**15/01/98**	0.3	-61.9
02/06/98	2.4	-20.8	**12/02/98**	0.1	-67.6
28/08/98	10.5	-6.2	**12/03/98**	0	0.8
01/12/98	-0.2	14.4	**09/04/98**	-0.1	-15.3
			07/05/98	0.3	-6.9
GDP			**11/06/98**	-0.1	10.3
04/03/98	0.2	-619.4	**09/07/98**	-0.1	7.1
03/06/98	-0.8	39.1	**06/08/98**	-0.1	3.6
02/09/98	-0.6	-73.3	**10/09/98**	0.2	-81.3
02/12/98	-0.2	-7.4	**08/10/98**	0	-279.5
			12/11/98	0.4	-13.5
CPI			**10/12/98**	-0.1	51.9
28/01/98	-0.1	47.3			
29/04/98	0.0	37.6			
22/07/98	-0.1	78.3			
28/10/98	0.3	-396.9			

The unexpected component of the information content (in percentage) is reported as well as the corresponding size os the price volatility (in percentage) for each news release. The data set extends from 01/01/98 to 31/12/98.

References

Almeida, A., Goodhart, C. A. E. and Payne, R. (1996) "The Effects of Macroeconomic 'News' on High Frequency Exchange Rate Behaviour", *Financial Market Group Discussion Papers*, London School of Economics-Financial Market Group.

Artis, M. and Taylor. M. (1988), "Exchange rates, interest rates, capital controls and the European monetary system: Assessing the track record", in: Giavassi, F., Micossi, S. and Miller M. eds. The European monetary system, Cambridge; Cambridge University Press.

Baillie, R. T. and Bollerslev, T. (1990) "Intraday and Intermarket Volatility in Foreign Exchange Rates", *Review of Economic Studies*, vol. 58, pp. 565-585.

Baxter, M and Stockman, A. (1989), "Business cycles and the exchange-rate regime: Some international evidence, Journal of Monetary Economics Vol. 23, pp. 377-400.

Berry, T. D. and Howe, K. M. (1994) "Public Information Arrival", *The Journal of Finance*, vol. 49(4), pp. 1331-1346.

Bollerslev, T. and Melvin, M. (1994), "Bid-Ask Spreads and Volatility in the Foreign Exchange Market: An Empirical Analysis", Journal of International Economics, Vol. 36, pp. 355-372.

Campbell, J. I., Lo, A. W. and MacKinlay, A. C. (1997) *The Econometric of Financial Markets*, United States of America: Princeton University Press.

Cornell, B. (1982) "Money Supply Announcements, Interest Rates and Foreign Exchange", *Journal of International Money and Finance*, vol. 1(2), pp. 201-208.

De Grauwe, P., Dewachter, H. and Embrechts, M. (1993), Exchange Rate Theory: Chaotic Models of Foreign Exchange Markets, Oxford; Blackwell.

Dornbusch, R. (1980) "Exchange Rate Economics: Where Do We Stand?" *Brookings Papers on Economic Activity*, vol. 1, pp. 143-185.

Dornbusch, R. Frankel, J.A. (1997), "The flexible exchange rate system, experience and alternatives. NBER Working Paper no. 2464.

Ederington, L. H. and Lee, J. H. (1993) "How Markets Process Information: News Releases and Volatility", *The Journal of Finance*, vol. 48(4), September, pp. 1161-1191.

Ederington, L. H. and Lee, J. H. (1995) "The Short-Run Dynamics of the Price Adjustment to New Information", *Journal of Financial and Quantitative Analysis*, vol. 30(1), March, pp. 117-134.

Edwards, S. (1982a) “Exchange Rates and ‘News’: A Multi-Currency Approach”, *Journal of International Money and Finance*, vol. 1(3), pp. 211-224.

Edwards, S. (1982b) “Exchange Rate Market Efficiency and New Information”, *Economics Letters*, vol. 9, pp. 377-382.

Eichengreen, B. (1988), “Real exchange rate behavior under alternative international monetary regimes; interwar evidence”, European Economic Review, vol. 32, pp. 363-371.

Engel, C. M. and Frankel, J. A. (1984) “Why Money Announcements Move Interest Rates: An Answer from the Exchange Rate Market”, *Journal of Monetary Economics*, vol. 13, January, pp. 31-39.

Fama, E. F. (1970) “Efficient Capital Markets: A Review of Theory and Empirical Work”, *The Journal of Finance*, vol. 25(2), pp. 383-417.

Frankel J. and Froot, K. (1987) “Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations” American Economic Review Vol. 77, pp. 133-53.

Frankel, J. A. and Hardouvelis, G. A. (1985) “Commodity Prices, Money Surprises, and Fed Credibility”, *Journal of Money, Credit and Banking*, vol. 17(1), pp. 425-438.

Frankel, J. A. (1981) “The Collapse of Purchasing Power Parities During the 1970s”, *European Economic Review*, vol. 16(1), pp. 145-165.

Goodhart, C. A. E. and Giugale, M. (1993) “From Hour to Hour in the Foreign Exchange Market”, *The Manchester School*, vol. 41(1), March, pp. 1-34.

Goodhart, C. A. E., Hall, S. G., Henry, S. G. B. and Pesaran, B. (1993) “News Effects in a High-Frequency Model of the Sterling-Dollar Exchange Rate”, *Journal of Applied Econometrics*, vol. 8, pp. 1-13.

Goodhart, C. and Smith R. (1985),”The Impact of News on Financial Markets in the United Kingdom”, Journal of Money, Credit and Banking”, Vol. 17, pp. 507-511.

Hakkio, C. S. and Pearce, D. K. (1985) “The Reaction of Exchange Rates to Economic News”, *Economic Inquiry*, vol. 23, pp. 621-636.

Hardouvelis, G. A. (1984) “Market Perceptions of Federal Reserve Policy and the Weekly Monetary Announcements”, *Journal of Monetary Economics*, vol. 14(2), pp. 225-240.

Hardouvelis, G. A. (1988) “Economic News, Exchange Rates and Interest Rates”, *Journal of International Money and Finance*, vol. 7(1), pp. 23-25.

Harvey, C. R. and Huang, R. D. (1991) "Volatility in the Foreign Currency Futures Market", *The Review of Financial Studies*, vol. 4(3), pp. 543-569.

Harvey, C. R. and Huang, R. D. (1992) "Information Trading and Fixed Income Volatility", *Unpublished working paper*, Duke University.

Hogan, K. and Melvin, M. (1994) "Sources of Meteor Showers and Heat Waves in the Foreign Exchange Market", *Journal of International Economics*, vol. 37, pp. 239-247.

Karfakis, C. and Kim, S. J. (1995) "Exchange Rates, Interest Rates and Current Account News: Some Evidence from Australia", *Journal of International Money and Finance*, vol. 14(4), pp. 575-595.

LeRoy, S. F. (1989) "Efficient Capital Markets and Martingales", *Journal of Economic Literature*, vol. 27(4), December, pp. 1583-1621.

MacDonald, R. and Torrance, T. S. (1988) "Exchange Rates and the "News": Some Evidence Using UK Survey Data", *The Manchester School*, vol. 56(1), March, pp. 69-76.

MacDonald, R. and Torrance, T. S. (1990) "Expectations Formation and Risk in Four Foreign Exchange Markets", *Oxford Economic Papers*, vol. 42, pp. 544-561.

Karfakis, C. and Kim, S. J. (1995) "Exchange Rates, Interest Rates and Current Account News: Some Evidence from Australia", *Journal of International Money and Finance*, vol. 14(4), pp. 575-595.

MacDonald, F. and Zis G. (1989), "The European monetary system: Towards 1992 and beyond", Journal of Common Market Studies", Vol. 27, pp. 183-202.

Meese, R. and Rogoff K. (1983) "Empirical exchange rate models of the seventies", Journal of International Economics, vol 14, pp. 3-24.

Melvin, M. and Tan, K. (1996), "Foreign Exchange Market Bid-Ask Spreads and the Market Price of Social Unrest" Oxford Economic Papers, Vol. 48, pp.329-341.

Mussa, R. (1979) "Empirical Regularities in the Behaviour of Exchange Rates and Theories of the Foreign Exchange Market", *Carneige-Rochester Conference Series on Public Policy*, Autumn, vol. 11, pp. 9-57.

Mussa, M. (1986), "Nominal exchange rate regimes and the behavior of real exchange rates: Evidence and implications", Carnegie-Rochester Conference Series on Public Policy, Vol. 25, pp. 117-214

Pearce, D. K. (1990) "Information, Expectations, and Foreign Exchange Market Efficiency", in Grennes, T. (ed.) *International Financial Markets and Agricultural Trade*, Canada: Westview Press, pp. 214-260.

Rao, M. (1993), “Excessive Exchange Rate Volatility: A Possible Explanation Using Chaos Theory”, Journal of Foreign Exchange and International Finance, Vol. 7, pp. 279-301.

Roley, V. (1987) “US Money Announcements and Covered Interest Parity: The Case of Japan”, *Journal of International Money and Finance*, vol. 6(1), pp. 57-70.

Rose, A. (1994), “Are Exchange Rates Macroeconomic Phenomena?”, Federal Reserve Bank of San Francisco Economic Review Vol. 1, pp. 19-30.

Singh, R. A. (1993) "Response of Stock Prices to Money Supply Announcements: Australian Evidence", *Accounting and Finance*, vol. 33(3), November, pp. 43-59.

Singh, R. A. (1995) "Response of Financial Markets to Announcements of the Australian Current Account Balance", *Accounting and Finance*, vol. 35(2), November, pp. 155-174.

Tanner, G. (1997) “A Note on Economic News and Intraday Exchange Rates”, *Journal of Banking & Finance*, vol. 21, pp. 573-585.